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Powder Makes A-1 Apple Juice

Reconstitutes in cold water within 90 seconds to provide quality beverage . . . Desiccant curbs lumping . . . Process steps detailed

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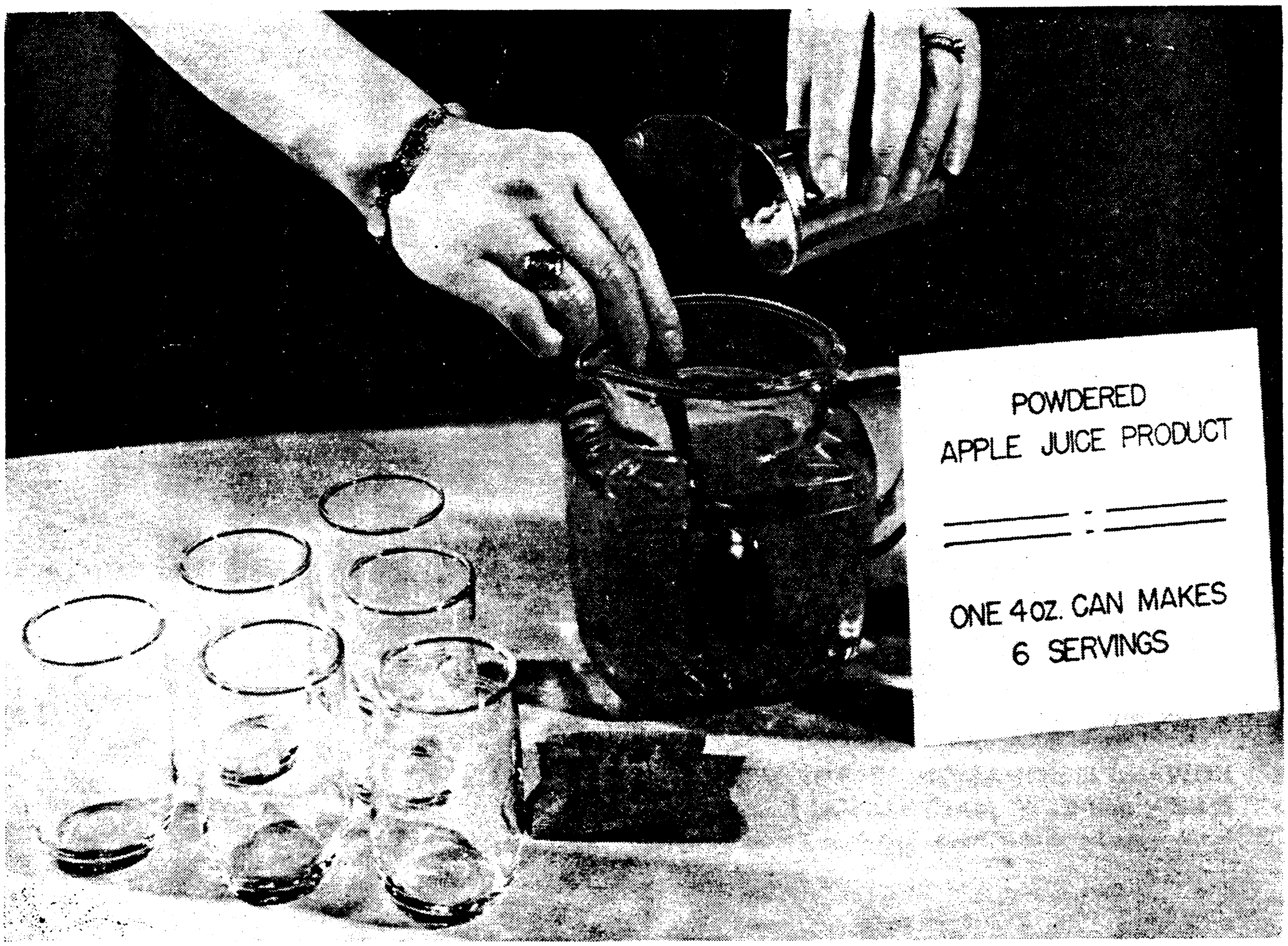

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A powdered apple juice product that yields a beverage of excellent fresh fruit flavor now has been developed by USDA.

Here, a 4-oz. can holds about 100g. of the new powder, which dissolves, with stirring, in 5 cans of cold water within 1½ min. This provides some 25 oz. (12.5 deg. Brix) of a beverage very closely resembling the drink prepared from the concentrate before drying.

The powder has an apparent, or bulk, density of about 0.9g. per ml. and a moisture content around 2.7%. Being hygroscopic, it must be processed in a low-humidity atmosphere in order to avoid lumping.

Moreover, to prevent this condition in subsequent storage, there is included in the can a desiccant envelope containing anhydrous calcium oxide. The envelope is made from a tough, sift-proof, moisture-permeable paper.

This new powder-drink development is an extension of prior USDA work on dehydrated fruit juice powders. Strashun and Talburt[1] dehydrated various juice concentrates in a "puffed" form and then added back natural flavoring constituents. Eskew *et al*,[2] dried a sweetened Concord grape juice concentrate containing added natural flavoring constituents and reported that a beverage prepared from the powder possessed good flavor.

Pilot-Plant Process

Apparatus: Here, the apple juice concentrate was prepared using equipment similar to that described in an earlier publication by Eskew *et al*.[3] This was dried in a vacuum tray dryer of conventional design. Cast-iron platens were supplied, with water controllable at any desired temperature from tap water to 200 deg. F.

Dryer trays were of #18 gage stainless steel with No. 4 finish. Vacuum was provided by an oil-sealed rotary type vacuum pump equipped with an oil clarifier for removing water continuously. Water vapor from the dryer was condensed inside the tubes of a vertical surface condenser.

The dried juice was ground in a small laboratory-size hammer mill running at low speeds and with a coarse screen of slot openings $\frac{1}{16}$ in. by $\frac{15}{32}$ in. The finished powder with desiccant envelopes was packaged in size 202 x 214 (4-oz.) cans. This grinding and packing was done in a specially designed cabinet where ambient relative humidity was reduced below 15% before the dried mass was brought into it. Cans were sealed with a small hand vacuum double seamer.

Preparation of Concentrate: Fresh apple juice was pressed from a blend of 1 part Northern Spy, 1 part McIntosh, 1 part Stayman, and 2 parts Jonathan apples. The juice was then stripped of essence, depectinized, clarified, and concentrated as described,[8] except that the concentration was increased to 83 deg. Brix. Brix-acid ratio of the concentrate was 24.2, acid being expressed as malic.

Formulation of the Concentrate for Drying: Powders of three formulations were made for evaluation by a trained taste panel. Powder "A" was dried from full-flavor apple juice concentrate—that is, concentrate containing the essence originally recovered from the fresh juice, and without addition of sugar or acid. The beverage from this powder had an excellent fresh-apple flavor.

Powder "B" was dried from a concentrate containing added sucrose equal in weight to the apple juice solids, citric acid to provide a palatable Brix-acid ratio, and an amount of essence to maintain the essence solids ratio characteristic of apple juice. The beverage from this powder had an excellent fresh-apple flavor equal to, or slightly better than, that of powder "A".

Powder "C" was dried from a mixture of the same composition as "B", except that dextrose was substituted for sucrose. The beverage from this powder was decidedly deficient in apple flavor compared to the other products.

Although the beverage from powder "B" was not significantly superior to that from powder "A", the use of sucrose as an additive offers advantages. Because sucrose does not enter into the reactions which develop off-flavors, it may be expected to lessen deterioration of the product during drying and storage by the mere dilution of the apple juice solids. Also the cost of the product is reduced by substituting some sucrose for the more expensive apple juice solids; thus tending to expand the market for apple products.

As a result of the taste-panel findings described above, the 83 deg. Brix apple juice concentrate was formulated for drying as for powder "B"—that is, by adding sucrose (as 83 deg. Brix solution) in an amount equal to the apple juice solids, citric acid solution to provide a palatable Brix-acid ratio, and essence in sufficient quantity to maintain the essence-solids ratio of fresh apple juice.

Drying: The mixture, now at about 80 deg. Brix, was spread onto the stainless steel dryer pans with a loading of 0.9 lb. of concentrate per square foot of pan area. Previously, the pans had been coated with a thin film of appropriate wax (such as Johnson's Corrosive Inhibitor Wax*) so that the material could be easily removed after drying.

The pans were placed in the dryer, the dryer door closed, and the concentrate brought to 160 deg. F., as indicated by thermocouples. The dryer then was evacuated and the material dried under conditions illustrated in our accompanying chart.

Drying commenced with vigorous foaming of the concentrate when the absolute pressure inside the dryer had reached about 7 in. of mercury. The foam rose to a maximum height of about 2½ in. A portion of the log of a typical run (accompanying table) illustrates the relationship of concentrate temperature and absolute pressure during the foaming period.

After the foam had subsided, the concentrate temperature began to rise from 115 deg. F. In about 30 min. temperature of the material reached 160 F. and was maintained at this level for the duration of drying. Total elapsed time from start of foaming to start of cooling was 130 min.

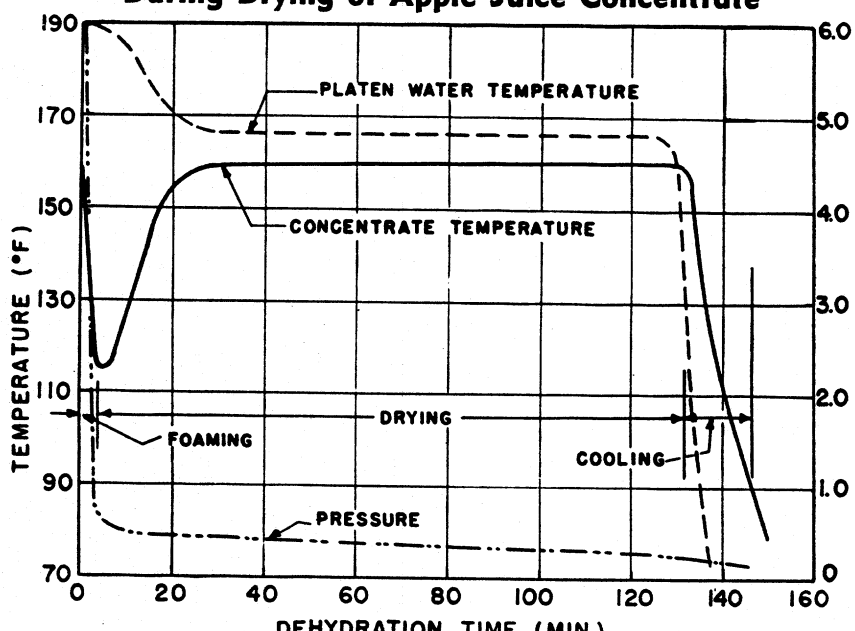
The absolute pressure inside the dryer, which had reached 0.6 in. of mercury at the end of the foaming stage, was reduced to 0.35 in. after 84 min. of operation, corresponding to a boiling point of about 47½ F. for water. The condensate, at about 47 F., now was removed from the receiver to preclude its boiling, and all further water vapor evolved from the concentrate was discharged through the vacuum pump. From this point to the end of the drying cycle the absolute pressure fell off to a low of about 0.20 in. of mercury.

Platen water temperature was regulated as needed to adjust and maintain concentrate temperature. For instance, the concentrate was brought to 160 F. before drying by using platen water at 190 F. And at the start of the foam-

* Mention of products in this article does not imply USDA recommendation or endorsement over other products not mentioned.

TEMPERATURE-PRESSURE RELATIONS

During Drying of Apple Juice Concentrate



And During Foaming Period

(Portion of Typical Log)

Time (Min.)	Concentrate Temperature (Deg. F.)	Absolute Pressure (In. Hg)	Progress of Foaming
0	160	7	Foaming begins
1	145	5	
2	130	3	Foam reaches 2½-in. height
3	120	1	
4	115	0.7	Foam layer begins to subside
5	115	0.6	Foaming ends

ing stage, the platen water temperature was gradually reduced to 165 F. to bring the concentrate temperature back to 160 F. and maintain it there.

At the end of drying proper, the product was molten. It was cooled by circulating cold water through the platens while maintaining the vacuum on the dryer. When the product reached 90 F., the dryer was opened and the pans removed. At this temperature the product was brittle. It was taken out by inverting the pans and tapping the bottoms briskly, whereupon the glass-like material fractured and dropped in pieces. These pieces, placed in a dried bottle containing desiccant envelopes, were ready for grinding and packaging.

Grinding: When its moisture was less than about 3%, the dried material was friable and could be readily comminuted if the ambient temperature was below about 90 F. At higher temperatures the material became increasingly plastic so that it could not be ground in the hammer mill. An atmosphere of relative humidity below 15% was necessary during all processing steps to prevent the highly hygroscopic dried product from rehydrating.

Under favorable conditions of temperature and relative humidity, the material was ground to coarse granular particles with no product retained on a 10-mesh screen (0.065-in. opening). Particle size ranged in distribution from fine powder up to the size just passing through a 10-mesh screen. Percent of fine particles was kept low because caking of the powder probably is a function of particle-size distribution, with high percentage of fines increasing the likelihood of agglomeration.

Coarser particles and fewer fines were obtained when using slower mill speeds and coarser screens. The powder did not cake when thus ground.

Packaging: The powdered juice product was hermetically sealed in number 202 x 214 cans. Each can carried an envelope containing a desiccant.[1, 4, 5] Weight of desiccant (anhydrous calcium oxide) was about $\frac{1}{10}$th the weight of the powder.

A comprehensive study of the storage properties of this apple product is in progress. Concentrate similar to the starting material for drying has maintained good flavor after 9 months storage at room temperature (73 deg. F.). The powdered material, with its extremely low moisture content, is expected to have good keeping properties even at elevated temperatures. Until storage tests are completed, however, the process is not recommended for commercial adoption.

References

1. Strashun, S. I., and Talburt, W. F., "Puffed Powder From Juice", FOOD ENGINEERING, *25*, 59-60, Mar. 1953.
2. Eskew, R. K., Sinnamon, H. I. and Turkot, V. A., "Powdered Grape Juice," *Food Tech.*, *8*, 27-28, Jan. 1954.
3. Eskew, R. K., Redfield, C. S., and Phillips, G. W. M., *High-Density, Full-Flavor Apple Juice Concentrate*, AIC-315, USDA, Aug. 1951.
4. Howard, L. B., "Desiccants Improve Dry Packs", *Food Packer, 26*, (4), 31 (1945).
5. Howard, L. B., "Factors of Processing and Storage That Affect Quality", *Canner*, *100*, (13), 46, 48, 50 (1945).